

I. INTRODUCTION: MAN AND HIS TOTAL ENVIRONMENT

As man continues to push the limits of the resources available to him on Earth, it becomes increasingly important that he understand the physical processes which control the Earth's total environmental system. It is through such an understanding that man can hope to anticipate environmental changes and thereby plan and manage more effectively the utilization of these finite resources. Beyond the satisfaction of basic physical needs, the advancement of civilization toward an ever-improving quality of life is likewise dependent upon man's interaction with his entire environment.

The Earth's environment embraces not only the immediate surroundings of which we are visually aware but also a much larger region of space consisting of the atmosphere and magnetosphere which extends outward a hundred thousand kilometers above the surface of the Earth. This larger system is controlled externally by electromagnetic and particle energy from the Sun and internally by the dynamic interchange of energy between the solid Earth, oceans, the atmosphere, and the magnetosphere. It is this exchange of energy that determines the structure of the Earth's environmental system and that ultimately controls, for example, our large-scale climate and local weather patterns. If we

can understand the interactive processes within the Sun-Earth system, we can predict and accommodate the terrestrial effects of changes that take place in the Sun.

Because of the interactive nature of the components of the Earth environmental system, man has realized that his ecological concerns must assume a global perspective. We have all been struck by the delicacy of our environment on a local scale, as for example in the pollution of streams and the resultant damage to biological systems. We are now apprehensive that this same delicacy is present on a global scale where the infusion of relatively minor quantities of pollutants into the atmosphere may have drastic effects on the characteristics of the stratosphere which protects us from the Sun's ultraviolet radiation. Stratospheric effects are but one symptom of the larger problem of assessing the effects of man's effluents on his sensitive environmental system. If we are to survive, we must protect this system; and to protect it we must understand the processes that control it.

Hence, we have in the Sun-Earth system a chain of coupled regions that are controlled initially by a variable solar input and subsequently by the processes in which energy propagates through the magnetosphere and atmosphere. This is a chain of events that generates those constituents of the atmosphere shielding us from solar ultraviolet radiation, that

determines the nature of the ionosphere upon which we rely for essential communications, and that leads to the development of atmospheric circulation, the dominant force in our weather patterns and climate. It is the workings of this interactive system that man must strive to understand.

When we are successful in achieving this understanding, we will be able to compile long-range environmental forecasts, which will, for example, predict the effects of man's pollutants on the environment and give advanced information on major weather patterns in given geographical areas for periods of months or perhaps even years. These forecasts will be supported on a continuing basis by an adaptive observation program tailored toward specific measurements of the crucial parameters which drive the environmental system. Forecasts of this type, in the context of a working understanding of the solar-terrestrial system, are needed by policy makers, environmentally affected organizations, and individual citizens alike. Reliable projections of environmental factors can be a great benefit to the nation and to mankind.

Man now has the ability to move into space with sophisticated instrumentation to observe his environment and to probe its intricate workings. A program to marshal this capability and ultimately to realize responsible environmental management is within our reach. It is, however, a program of substantial challenge and magnitude. In particular,

it is a program that cries for the scope and versatility of a manned space station. The dramatically successful solar observatory on the Skylab space station is typical of the scale of instrumentation that must be brought to bear on this objective. Lesser capabilities will be inadequate. Further insight into requirements for this program will unfold in the course of subsequent paragraphs.

The recognition of this opportunity to benefit mankind is not new, of course. It was addressed deeply in the NASA Outlook for Space. NASA programs have studied the Sun-Earth system for a number of years, beginning with the early Explorer satellites which produced a wealth of information on the system's morphology and dynamics. With the Shuttle-Spacelab era will come opportunities to carry out experiments involving the scientist directly in probing specific physical mechanisms which control the Earth's surroundings. During the short-duration Spacelab flights, new instruments and experimental techniques will be developed for the remote sensing of the Sun, the atmosphere, and the magnetosphere and for controlled active probing of the atmosphere and magnetosphere. Many of the experiments developed for Spacelab will have direct extension to longer duration missions. An example of this is the global measurement of features of the Earth's atmosphere and its seasonal variation and solar cycle dependence.

These longer missions should be carried out in a manned Space Station having a Solar-Terrestrial Observatory that would be operated initially in a low Earth orbit with a follow-on mode at geosynchronous orbit. This observatory could be one module of a station carried to orbit in the Space Shuttle. Through continuous observations of the Sun and Earth, the observatory will measure the relationships between solar activity changes and terrestrial responses. It can make global assessments of the effects of natural and man-induced trace materials introduced into the atmosphere and magnetosphere. The simultaneous, long-duration remote sensing of the Sun, the magnetosphere, and the atmosphere should give us the insight and understanding that is necessary to model, predict, and accommodate changes in our complex environmental system. Environmental management is a crucial part of our future; the Solar-Terrestrial Observatory will play an essential role.

Fundamentally, we have but two choices: gamble with our future or work to obtain a complete understanding of our Sun-Earth environmental system.